

(HPD), in an isotonic saline solution at a concentration of 2.5 mg/ml was used as the photosensitizer. Lyophilized DHE was kept in the dark at -70°C . until just before use, and reconstituted with water resulting in an isotonic solution. DHE was administered intraperitoneally at 10 mg/kg two days before laser treatment.

Treatment sites were located on the backs of all guinea pigs in two linear arrays of 3 sites. Each animal had a total of 6 sites treated, 3 on the left side and 3 on the right. Skin surface temperature was monitored throughout treatment.

invention (bottom). Sites treated with the free optical fiber showed increasing areas of eschar as the light dose increased. Guinea pigs receiving light and no DHE showed no evidence of eschar formation at any dose. Temperatures increased by no more than 2.9°C . during treatment.

The relevant data from the tests performed in Example 2 are presented below in Table 1.

TABLE 1

Photodynamic effect of integrating sphere versus free optical fiber on guinea pig skin						
Light dose	Sphere 1	Fiber 1	Sphere 2	Fiber 2	Sphere 3	Fiber 3
10 J/cm ²	0*(0%)†	.30(38%)	0(0%)	.15(19%)	0(0%)	.15(19%)
20 J/cm ²	.86(109%)	.51(65%)	.78(100%)	.64(82%)	.98(125%)	.50(64%)
30 J/cm ²	.86(109%)	.92(124%)	.82(105%)	.95(121%)	1.0(129%)	.89(114%)

Light doses of 10, 20, and 30 J/cm² were delivered to all 3 guinea pigs. Each animal received 3 sites treated to the above doses with an open optical fiber on one side, and with the integrating sphere on the contralateral side. The experiment was repeated in triplicate. All treatment doses were delivered in anatomically identical locations on the left and right sides of each guinea pig. After light administration treatment sites were lightly marked in indelible black ink. Two animals were not given photosensitizer, otherwise they were treated in an identical manner.

Treatment sites were evaluated for eschar formation on day 7. This time period was determined to correspond to maximal visible damage. Lesions were only compared with those on a given animal to control for variation in absorption of HPD between animals. Treatment sites were photographed on day 7, with a ruler to allow standardization of treatment sizes. Photographs were then placed in front of a video camera and digitized by a computer. Digitized images were then subject to analysis of eschar size in treatment areas as computed using the digital imaging program. These values were compared to ideal area of illumination which were 1 cm circles in each case. Circles made by the free optical fiber were made to be exactly 1 cm in diameter by adjusting the treatment height of the optical fiber. The integrating sphere had an output port forming a circle 1 cm in diameter, which was placed directly in contact with the skin of each guinea pig.

Area of eschar as calculated using a computer based graphics system are shown in Table 1. Eschars more closely corresponded with the size of the treatment field when using the integrating sphere than when using the free optical fiber. Eschar sizes were compared to an ideal 1.0 cm² circle, which has an area of 0.785 cm². Treatment sites varied from the ideal circle by an average of only 12.8% when treated with the integrating sphere, versus 40.7% with the free optical fiber. Small eschars were produced centrally by the free optical fiber at a light dose of 10 J/cm² with the free optical fiber but not with the integrating sphere. This dose has been shown to be below the threshold for eschar formation in guinea pig skin when using uniform treatment beams. Uniform eschars were produced with the integrating sphere at light dose of 20 and 30 J/cm².

FIG. 5 shows eschars formed on guinea pigs which were given photodynamic therapy utilizing a free optical fiber (top) and an integrating sphere according to the present

In Table 1, areas of eschar produced by light administration to guinea pigs given 10 mg/kg DHE, as calculated by computer graphics program are expressed in cm². Results are paired with designations 1, 2 and 3 referring to treatments done on either side of each of the three guinea pigs. Each guinea pig received a total of six reaction sites: three on the first side using the integrating sphere, and three on the other side using the free optical fiber. "Sphere" refers to the side treated with the integrating sphere and "Fiber" refers to the side treated with the free optical fiber to the light doses shown.

The expected area for a 1 cm diameter circle using πR^2 is 0.785 cm². Each area (in parentheses) is expressed as a percentage of this expected value.

From the above, it can be seen that the integrating sphere of the present invention provides a highly uniform illumination beam, which is particularly applicable to photodynamic therapy. In this regard, the present invention further provides additional advantages such as elimination of required shielding, and quick and easy application of light over a desired treatment site. Beyond phototherapy procedures, the integrating sphere of the present invention can be used in any application in which a highly uniform illumination field is required, such as optical examination and imaging.

Although the present invention has been described with reference to particular means, materials and embodiments, from the foregoing description, one skilled in the art can easily ascertain the essential characteristics of the present invention and various changes and modifications may be made to adapt the various uses and characteristics without departing from the spirit and scope of the present invention as described by the claims which follow.

We claim:

1. A light delivery device which comprises:

a hollow spherical shell which defines an outer spherical surface and a spherical cavity therein, and which includes a diffusive reflective inner surface;

an input aperture formed within said hollow spherical shell for passing a beam of light into said cavity;

a diffusive reflective surface within said cavity which is supported away from the inner surface of said hollow spherical shell and aligned with said input aperture, whereby light which passes through said input aperture into said cavity is reflected off said diffusive reflective